APPLICATION OF HACCP (HAZARD ANALYSIS CRITICAL CONTROL POINT) TO COW TELEMEA CHEESE PRODUCTION

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Abstract

Nowadays, Hazard Analysis of Critical Control Points (HACCP) has become a prerequisite for transactions involving food products. Application of HACCP system in the cheese making industry proved to be beneficial and profitable, influencing consumer confidence by producing safe cheese with consistent quality. Cow TELEMEA is a ripened cheese which due to its composition (moisture, salt level) and properties is susceptible to contamination. The aim of this study was to detail the flow diagram, to assess physical, chemical and biological hazards and to identify critical control points for cow TELEMEA cheese on processing line. The results have revealed that physical, chemical and biological hazards may occur during processing and four critical control points were found: raw milk reception, raw milk storage, milk pasteurization and cold storage of cheese.

Kay words: *HACCP, cow, TELEMEA cheese, hazards*

Introduction

Dairy products are considered to be amongst the most nutritionally complete foods. Unfortunately, this characteristic also makes them highly susceptible to bacterial contamination that can lead to outbreaks of food borne disease. Cheese is a very popular dairy product and appreciated by consumers.

Since modern dairy plants are capable of processing large volumes of products, outbreaks can potentially affect large sectors of the population, including highly sensitive population – children, pregnant women, elderly (Kiŝmartin et. al., 2013).

Pathogenic microorganism (biological hazards) such as *Salmonella spp., Staphylococcus spp., Listeria monocytogenes, Escherichia coli O157:H7, Campylobacter jejuni, Yersinia enterocolitica* can contaminate milk and milk products and cause foodborne diseases. Noroviruses are the leading cause of foodborne outbreaks of acute gastroenteritis and the most common cause of sporadic infectious gastroenteritis amongst persons of all ages. Antibiotics and antimicrobial residues from milk and milk products can also represent potential health risks to consumers. Other chemical hazards include herbicides, pesticides and toxic metals, and physical hazards include hairs and needles. The dairy industry realised the need for proactive procedures hence implementing HACCP (Hazard Analysis and Critical Control Points) for ensuring that safe dairy products would reach the consumers (Papademas et. al., 2010, El-Hofi et. al., 2010). The HACCP concept was originally developed by the Pillsbury Company for the United States space program, to produce foods which were 100% safe. To achieve this end, Pillsbury controlled all aspects of the food production system including the raw materials, the process, and the environment. After Codex Alimentarius published “Guidelines for application of the Hazard Analysis Critical Control Point (HACCP) system”, HACCP principles have started to become legal obligation in many countries, including Romania.

The objective of our study was to detail the flow diagram, to assess physical, chemical and biological hazards and to identify critical control points for cow TELEMEA cheese on processing line.

Material and methods

Description of dairy product

Cow TELEMEA is a ripened cheese, prepared with pasteurized cow milk, rennet and salt. The cheese is cut into small blocks (of 400 g) and vacuum packed in polyethylene bags along with a little brine. The physical and chemical composition is presented in table1.

Table 1.

Cow TELEMEA cheese composition

Physical and chemical composition		Micobiological parameters	
Moisture % max.	max. 62%	*E.coli*	min.100 cfu/g
Fat in dry matter % min.	min. 38%	Coagulase positive *Staphylococcus*	min.100 cfu/g
Fat in product % min.	min.14,5%	*Salmonella spp.*	abs./25g
Protein % min.	min.16%		
Salt % max.	8% in product 16-20% in brine	*Listeria monocytogenes*	abs./25 g
Acidity °T	150°T		
Texture	Firm and compact		
Taste	Creamy, slightly acid and salty taste		
Color	White /Ivory-white		

Cow TELEMEA cheese flow diagram

After collection and transport, cow milk is received in dairy plant. Samples of raw milk are sent to dairy plant laboratory, to test physical, chemical properties (temperature, pH and acidity, density, fat and protein content) and microbiologic (NTG and somatic cells, antibiotic residues) quality. The proper milk is mechanically filtrated and stored in silo tanks, at 4°C, until processing. The milk is standardized at 2,8 % fat, pasteurized at 85°C, 120 sec., and homogenized. The pasteurized milk, cooled at 46-48°C is directed in coagulation tanks and inoculated with, calcium chloride ($CaCl_2$), lactic acid and rennet.

The coagulation stage lasts 30-50 min. at 20-25°C. The curd obtained is processed by cutting into small cubes leads, shaping and pressing to syneresis (expulsion of whey and contraction of curd). After syneresis, the curd is cut into 400 g cheese small blocks and salted in 18-22% brine, 24 hours, at 14-16°C. After salting, the cheese is packed in polyethylene bags and covered with 16-18% brine and directed to ripening storage. The ripening stage lasts 20 days at 14-16°C. The storage of cheese is made at 2-8°C and the shelf life is 120 days in appropriate conditions.

The codex protocol for the application of HACCP system includes seven principles (table 2).

Table 2.

HACCP principles

No.	Principles
1	Establish the potential hazards and conduct a hazard analysis
2	Determine the Critical Control Points (CCP)
3	Establish critical limits for each CCP
4	Establish a monitoring system to control each CCP
5	Establish the corrective action to be taken when monitoring indicates that a particular CCP is not under control
6	Establish verification procedures to confirm that the HACCP system is working effectively
7	Establish documentation concerning all procedures and records

Results and discussion

The hazard analysis and CCP determination for cow TELEMEA cheese using decision tree have revealed that physical, chemical and biological hazards may occur during processing steps and four critical control points were established: raw milk reception, raw milk storage, milk pasteurization and cold storage of final product. Two CCP_s are detailed in tables 3 and 4.

Receiving of raw milk*:* the milk should be obtained from healthy animals under hygienic conditions. There are many factors that ensure the high quality of raw milk, but biological, chemical and physical hazards are occasionally identified in raw milk. Raw milk is a proper medium for the growth of microorganism and pathogenic bacteria such as *Salmonella spp., E. coli O157:H7, Campylobacter spp., Listeria monocytogenes, Staphylococcus aureus, Streptococcus spp.* can be derived from the udder, the environment, the milking equipment and employees. Also, raw milk may contain antibiotics, mycotoxins, toxic metals or chemicals (Mauropoulos et. al., 1999; Wiedmann et. al., 2006; Karns et. al., 2007).

This stage is the first ***CCP*** because the reception test stands for an acceptance test. Control of raw milk includes the determination of milk acidity (15-19°T), temperature (4-6°C), aerobic mesophilic count (<100.000 cfu/ml), somatic cell count (<400.000/ml), antibiotic residues (negative).

Table 3.

Hazard analysis and CCP1 (raw milk receiving) management

Critical control point CCP		
Stage	**Hazards**	**Critical limits**
Receiving of raw milk	*Biological:* spoilage and pathogenic microorganisms *(Salmonella spp., E. coli O157:H7, L. monocytogenes,* coagulase positive *Staphylococcus*, etc.) *Chemical:* antibiotics herbicides, pesticides, cleaning substances *Physical*: dust, hair, dirt	NTG max. 100.000 ufc/ml Somatic cells max. 400.000/ml Antibiotics residues-negative Temperature max. 6°C Acidity max. 19°T

Monitoring procedures			
What	**When**	**How**	**Who**
Milk temperature, acidity NTG, NCS Antibiotics presence	Before accepting each tanker load and immediately prior to use	Control of milk temperature and acidity Microbiological tests Test for the presence of antibiotics	Employee at reception stage: line manager, veterinarian
Corrective measures		**Verification**	**Records**
Who	**How**	**What** / **Who** / **When**	
Line manager, veterinarian Hold. Do not process until milk parameters have been tested. Reject any loads containing antibiotics		Thermometer record control. Line manager, daily. Lab control, microbiologist, every production date. CCP record control, line manager, daily. Internal audit, auditors, according to audit plan. Maintenance plan – maintenance division, according to plan. Measuring equipment calibration, externally, by legal requirements. The manager verifies corrective measures after deadline for conduction.	Data (temperature) record. Microbial analysis. CCP control record. Internal audit plan. Maintenance plan. Records of authorized institution about calibration or internal calibration record. Corrective/preventive measure claim.

Milk filtration: after reception, milk is filtrated to remove any extraneous material which represents a physical hazard (hair, soil, dust, dirt, etc.).

Storage of raw milk: if the milk is not used in day of production, it should be cooled at refrigerated temperature, below 6°C. The rapidity of milk cooling have a significant impact on its microbial flora. The cooling of milk greatly retards the growth of these mesophilic microorganisms (*Lactococcus spp., Enterococcus spp.*), but psychrotrophic bacteria, such as *Pseudomonas, Enterobacteriacea, Flavobacterium* and *Acinetobacter* will continue to grow slowly and dominate the flora. Among Gram- negative, some Gram-positive psychrotrophic bacteria are also found, usually of the genus *Bacillus*. At temperatures below 6°C, *Bacillus cereus* grows and forms spores, which are unafected by pasteurization. *Bacillus cereus* is of great importance because it is capable of producing a food poisoning toxin. Many yeasts and mould species are also characterized as being psychrotrophic and may contaminate the milk (Ali et. al., 2005; McSweeney, 2007). This stage is the second ***CCP*** and for controlling this point, storage temperature must be checked.

Milk standardization is made in automatic line - standardization systems by adding skimmilk or cream in whole milk. The fat content in standardized milk is 2,8 %.

Milk pasteurization is identified as a ***CCP*** stage in dairy plant, of all dairy products. Pasteurization at 85°C, 120 sec. destroy the vegetative forms of bacteria and also extend the shelf life of the product by reducing the number of spoilage microorganism (psychrotrophic bacteria, yeasts and moulds) from raw milk. However, the procedure of pasteurization, can not destroy or eliminate the toxins, bacterial agglomerations and residues of chemical substances, such as antibiotics and metals. Therefore, the existence of at least one critical control point before pasteurization is essential (reception of raw milk).

Pasteurized milk can have a bacterial flora consisting of thermoduric organisms that have survived pasteurization, such as corynebacteria, micrococci, enterococci, spores of *Bacillus* and *Clostridium* (Fernandes R., 2009). The storage of the product under appropriate conditions (temperature, relative humidity, etc), inhibits the growth of these bacteria.

The insuffcient heat treatment may favour the survival of pathogenic bacteria. The pasteurization efficiency should be tested (alkaline phosphatase test) and controlled by establishing management procedures such as maintenance of correct temperature and holding time and efficiency of Cleaning-In -Place (CIP) system. The plate heat exchanger should be cleaned at least once a day (0.5% NaOH, 65±70°C). Cross-contamination of milk after pasteurization stands probably for the greatest risk of a hygiene breakdown and the main sources of contamination are the air, water, equipment, employees, starter cultures, rennet and packaging. Control laboratory does frequently the sampling from the sources which are regarded suspect and exposed to contamination (Mauropoulos et. al., 1999).

Table 4.

Hazard analysis and CCP2 (pasteurization) management

Critical control point CCP			
Stage		**Hazards**	**Critical limits**
Milk pasteurization 85°C, 120 sec		Biological: survival of pathogenic microorganisms (aerobic mesophilic bacteria, *Salmonella*, *Escherichia coli*, *Listeria monocytogenes,* coagulase positive *Staphylococcus*) due to improper pasteurization temperature and/or time.	< 85°C < 120 sec.
Monitoring procedures			
What	**When**	**How**	**Who**
Pasteurization temperature Pasteurization time	Continuously during pasteurization Before start-up of pasteurization	Control of starting and final temperature for every batch in buffer tank. Control of thermograph records to assure that thermograph and probe detect same temperature. Control of vital equipment for temperature regulation (probes, valves, thermograph).	Employee at pasteurization stage: line manager, veterinarian

Corrective measures		Verification			Records
Who	How	What	Who	When	
Line manager, veterinarian If the temperature is not correct (equipment or power failure), line employee discharges the milk, to balance tank and circulate it to pasteurizer. The manager of line is informed and he decides on further actions and informs manager of maintenance if necessary.		Thermograph record control. Line manager, daily. Lab control, microbiologist, every production date. CCP record control, line manager, daily. Internal audit, auditors, according to audit plan. Maintenance plan – maintenance division, according to plan. Measuring equipment calibration, externally, by legal requirements. The manager verifies corrective measures after deadline for conduction.			Pasteurizer thermograph record. Microbial analysis. CCP control record. Internal audit plan. Maintenance plan. Records of authorized institution about calibration or internal calibration record. Corrective/preventive measure claim.

The coagulation stage is made after addition of $CaCl_2$, lactic acid and rennet solution in pasteurized and cooled milk. Rennet, in combination with lactic acid, causes coagulation of the milk by precipitating casein as an aqueous gel. When the acidity and curd firmness reach the correct level, the whey is separated from the curd (syneresis). The curd (coagulum) is processed by cutting, shaping and pressing to eliminate the whey and adjust the moisture content in cheese. After cutting, the cheese pieces are salted in brine.

Brine salting of cheese is made with 18-22 brine, for 24 hours. Salt influence the ripening stage trough its effects on water activity, contributes to the flavor and texture, extend the shelf life due to control of microbial growth and activity, and various enzyme activities in cheese (Fernandes R., 2009).

Packing and ripening of cheese: the salted cheese is packed in polyethylene bags and covered with 16-18% brine and directed to ripening storage. The packages must be kept in appropriate hygienic conditions and microbiologically tested. Ripened cheese require some degree of ripening for the full development of flavor and texture. During ripening, further moisture loss occurs, and a complex combination of microbial and enzymatic reactions take place, involving milk enzymes, the coagulant, and proteases and peptidases from the starter culture and non-starter microorganisms, which remain viable although their growth is inhibited. The ripening stage lasts 20 days at 14-16°C.

Cheese cold storage is made at 2-8°C and low relative humidity in storage rooms. To prevent the growth of undesirable microorganisms (spoilage and pathogens) as cross contamination, the temperature and relative humidity should be constantly monitored. This stage is identified as last **CCP** in cheese processing line, in dairy plant.

There are pathogens such as *Mycobacterium spp*. which endures extreme pH conditions and high values of salt concentration (Mauropoulos et. al., 1999). *Listeria monocytogenes* is a psychrotrophic bacteria which grows rapidly at 8-12°C, high moisture and 5.0 up to 6.0-7.0 pH conditions. *Stapylococcus aureus* is able to tolerate salt and moderate acidity, and can multiply during cheese manufacture and ripening. For that reason, pasteurization must destroy this pathogen.

Also, it is essential that adequate hygiene procedures to be practiced during cheese processing and ripening to prevent environmental contamination with *L. monocytogenes* (Fernandes R., 2009).

Conclusions

1. Implementation of the HACCP system in cheese processing line proves to be a necessary tool for improving the safety and quality characteristics of these dairy products.
2. Following hazard analysis, four CCP (critical control points) were established for cow TELEMEA cheese: raw milk reception, raw milk storage, milk pasteurization and cold storage of cheese.
3. The application of the HACCP system is not a stand-alone system, but it should be seen as an element of food safety management. It complements basic good hygienic practices in food safety assurance by targeting product-specific hazards and devising control measures necessary for managing risks relevant to the product and conditions of operations.

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